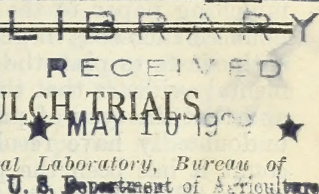


Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

UNITED STATES DEPARTMENT OF AGRICULTURE
 WASHINGTON, D. C.

SUGGESTIONS FOR PAPER-MULCH TRIALS

 BY L. H. FLINT, Associate Physiologist, Biophysical Laboratory, Bureau of
 Plant Industry


CONTENTS

	Page		Page
Introduction-----	1	Application of mulching paper—Con.	4
Soil conditions in relation to paper mulch-----	3	Methods-----	7
Application of mulching paper-----	4	Costs-----	7
Papers-----	4	General precautions-----	7

INTRODUCTION

The use of paper mulch in agriculture was originated in 1914 by C. F. Eckart in connection with the culture of sugar-cane in the Hawaiian Islands. Following a period of experimental trial the process was extended to pineapple culture and in 1922 attained appreciable economic importance in that industry. This method consists essentially of extending black paper over soil surfaces adjacent to crop plants, the paper serving to enhance growth chiefly through the suppression of weeds and through the increase of soil temperature and moisture.

In 1924 the United States Department of Agriculture began small trials with various types of paper mulches. These experiments were continued over a period of four years, during which various phases of the process received attention. The trials were reported in Technical Bulletin No. 75.¹ For the most part the paper used in these trials proved durable through several seasons and was of the type used extensively in the pineapple-growing industry of the Hawaiian Islands. These trials led to the conclusion that under a wide variety of crops and conditions a definite and appreciable plant stimulation resulted from the use of the paper. This conclusion has been substantiated by further experiments and by the results of a large number of trials by interested growers throughout the United States and Canada during the past season (1928).

Little is known, however, concerning the economic value of the process. The trials in 1928 were made with various types of paper of varying cost and durability. In most of these experiments there was no attempt to investigate the relations of the cost of the paper to the soil surface covered or to the durability of the paper, or the relations of the durability of the paper to the requirements of the

¹ FLINT, L. H. CROP-PLANT STIMULATION WITH PAPER MULCH. U. S. Dept. Agr. Tech. Bul. 75, 20 p., illus. 1928.

crop for which it was used. In many instances papers of a durability of several years, and proportionately expensive, were applied to crops maturing in a few months. No particular attention had been given to the development of methods for the adaptation of mulching paper to the growing of any one crop. The rather pronounced increases in growth reported from the use of paper had led enthusiasts to plan the covering of large areas; but without experimental evidence that the method was adapted to the local conditions and that the type of paper was satisfactory such a procedure would undoubtedly have resulted in many disappointments. On this account it has been the policy of the department to suggest that all initial trials be conducted on a small scale.

With the establishment of the fact of crop response for a variety of crops, soils, and seasons, the further study of paper mulch becomes of interest. From a technical viewpoint this study is associated on the one hand with types of papers and their suitability for different crops and on the other hand with the biophysical factors involved in crop production under the paper-mulch system. This technical study is being carried out by means of experiments at the Arlington Experiment Farm (Rosslyn, Va.) and elsewhere, but these experiments must be repeated throughout several seasons under varying conditions of soil, season, and climate before definite conclusions can be reached.

From an immediately practical standpoint the further study of paper mulch involves additional and extended field trials in the producing regions. The paper-mulch method is a new one in continental United States, and its economic utilization here is still in the experimental stage. Because the method is a new one there has been no thorough testing of available mulching papers and no studied development of methods for their adaptation to our crops. Those who have been fortunate in the selection of their papers and ingenious in applying them appear to have attained an appreciable and encouraging measure of success. Others who did not apply the paper until the season was well advanced, or who found that their paper had blown away or had disintegrated or had been interfered with in some other way, obtained results that were not indicative of the effectiveness of the paper. Whether the "best paper" for any crop and the "best method" of using it will make the method economic for use with a certain crop in a certain region is not a matter that can be determined without practical experiment and repeated trials in that particular region. The economy of the practice is particularly related to labor costs, to the type of crop, and to specific market conditions, and is therefore essentially a matter for the interested grower to determine for himself, with the experience of others to guide him. The solution of the problem requires initiative, resourcefulness, and hard work, but its solution appears to offer satisfactory rewards.

The wide interest in paper mulch indicates that the method will be given a thorough trial in this country. The experienced grower will recognize that the determination of the potential value of a system of culture so radical as the paper-mulching system, for any specific agricultural purpose, is pioneering work. Utilizing the system to economic advantage in continental United States will un-

doubtedly require the same research, resourcefulness, and industry that brought about its successful development in the Hawaiian Islands. Present paper costs are deemed to limit the application of the system in this country to the more intensive phases of our agriculture, but for these it appears to merit serious study.

The present circular is intended as a guide to growers interested in the practical possibilities of paper mulch, who are desirous of ascertaining through small trials whether or not they may make economic use of the stimulation of plant growth and other advantages which frequently result from the application of paper mulch.

SOIL CONDITIONS IN RELATION TO PAPER MULCH

The trials with paper mulch have not as yet indicated the desirability of any one particular method of soil preparation for general use. It is quite possible that on account of the modified soil conditions accompanying the use of paper mulch the present practices in relation to certain crops on unmulched soils may undergo some change. Nevertheless, such changes may be expected to develop gradually with further practical experience. For example, soil-moisture conditions produced under the mulch may be of such importance where irrigation or dry-land agriculture are practiced, or in regions of excessive rainfall, that a modification of present technic may be practicable and advisable. Or, again, the effectiveness of the paper in bringing about the rapid decomposition of weeds may possibly be utilized in the development of a modified system of green manuring. Further, the protection afforded by the use of certain types of paper against the packing of heavy soils by winter rains and snows may permit advantageous fall preparation of the soil for early spring planting of certain crops. On soils described as "cool and moist," however, the special desirability of applying the paper over slightly ridged beds has been shown to be due to the fact that under these conditions the soil temperature was increased through the reduction of evaporation and through heat absorption. At the same time the soil moisture was not unfavorably increased, as sometimes happened on such soils with paper and flat culture.

Little is known regarding the relation between the use of paper mulch and the application of fertilizers. The initial paper-mulch trials have indicated that the poorer the soil the greater the percentage difference between the mulched and the unmulched crop. Even with a relatively great increase in yield resulting from the mulch the yield might still be unprofitable. The absolute difference between mulched and unmulched crops increased with fertility. It is deemed entirely reasonable to look to the paper mulch for an increase in soil moisture and soil temperature. In so far as these factors may promote growth directly, well and good; but their indicated secondary effect in promoting the activity of favorable microorganisms in the soil, leading to an increased production of nitrates, can take place only through the same reduction of the organic materials in the soil which characterizes all the usual practices. The introduction of paper mulch into the pineapple-growing industry did not result in a reduction of the applications of manures or commercial fertilizers, but it did enhance the effectiveness of any added fertility.

Pending further investigation, the validity of this relationship may well be assumed in the use of paper mulch with crops in temperate climates.

APPLICATION OF MULCHING PAPER

PAPERS

There are at present two general types of mulching papers used during the growing season. These types are based on durability. Papers made for use with a single crop are designated as type A, while those made for use with two or more crops or for home gardens are designated as type B.

The type-A papers comprise those suitable for annual crops in field culture. They are designed to last as long as or somewhat less than the period during which the crop plants are in the field.

The type-B papers comprise the papers suitable for perennial crops in field culture, for a succession of annual crops in field culture, and for all home-garden purposes. They are appreciably stronger and more durable than the type-A papers. The paper that is used in pineapple culture is of type B.

METHODS

There are at present three principal methods of applying paper: (1) The placing of small squares of paper at regular distances, (2) the use of extended strips of paper with alternate uncovered soil

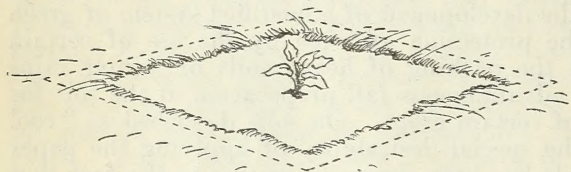


FIGURE 1.—Method of applying small squares of paper mulch, as used with certain vine crops in field culture

areas of approximately the same extent, and (3) the use of paper in strips without any uncovered soil except that exposed incidental to the establishment of the crop plants.

In the first method as applied to the growing of such crops as muskmelons, watermelons, cucumbers, squashes, etc., sections 3 by 3 feet were cut from 36-inch rolls of type-A paper. Holes of suitable size to permit field seeding or transplanting were then cut in the center, and the sections then were placed in the field. The seeds were planted just before the paper was placed over the prepared seed bed, or at any subsequent time. The best results were obtained, however, when the application of the paper was made before the seeds germinated. Transplanting into the field before the laying of the paper gave better results than transplanting through holes in the paper, as in the latter case it was difficult to firm the soil about the plants. The mulch-paper sections were made to hold "hot caps" in place when these were used. The type-A papers used in the above manner should be about disintegrated at the time of harvest. If they still remain intact, it indicates that a less durable and less expensive paper might be as effective. This method is outlined in Figure 1.

In the first method, as applied to the establishment of fruit and nut orchards, vineyards, shade and forest trees, etc., sections 3 by 3 feet were cut from 36-inch rolls of type-B paper. Cross-shaped slits

of suitable size were made in the center for single-stalk plants, and round holes with a slit to the outside were made for those with bushy tops. These sections were placed about the plants at the time they were set out in the permanent field planting, all outer edges being depressed and embedded in soil to insure protection against wind damage. For larger plants two sections 3 by 6 feet were cut from 36-inch rolls of type-B paper, each section was notched at the center of one long edge, and the two were overlapped slightly about the plant stock. All outer edges were covered with soil, and bricks, stones, or sods were placed on the overlaps. The type-B papers as above used were left in place until disintegration had destroyed their effectiveness.

The particular desirability of a single application of paper lasting several years as compared with an annual application of paper lasting for the growing season only is complicated at present by the lack of information regarding the influence of paper mulch during the winter season. The application of paper to well-developed orchard trees did not appear to be of general economic promise.

In the second method, as applied to the growing of such crops as tomatoes, peppers, eggplant, cabbage, and tobacco, the type-A paper 36-inches wide was unrolled over pre-

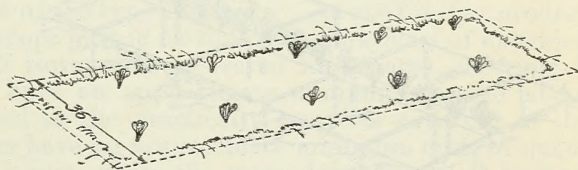


FIGURE 2.—Method of applying extended strips of paper mulch, as used with various crops in field culture

pared soil, and the edges covered with soil. The paper-covered area was slightly ridged so that the heat-absorbing value of the paper would not be reduced by any deposition of soil on top of the paper by subsequent rains. This method with type-B paper is the one used with pineapples, and the machine laying of the paper in such a way does not involve any mechanical difficulty. The young plants were set through cross-shaped slits, or in some instances suitable-sized disks of paper were removed. Double staggered rows of plants were set through at the desired intervals. The openings made for the plants also facilitated the entrance of rain water. The machine preparation of the slits may be readily accomplished at the factory if continued trials indicate the desirability of extensive application. With this method the middles required machine weeding. It is quite possible that if wider papers were available more than two rows of plants could be grown to greater advantage. For the present, however, the double-row system appears best for trials of the above-listed crops when hand set in the field. This method is shown in Figure 2.

With strawberries a similar system was used, a type-A paper being used in the Southern States, where this plant is grown as an annual, and a type-B paper being used elsewhere. Since the paper tends to prevent the establishment of runner plants, all plants desired were set out when the bed was made.

In the second method, as applied to the growing of such crops as sweet corn, potatoes, sweet potatoes, cabbage, and tobacco, when the eventual adaptation of the system to machine planting was projected

the use of type-A paper in 18-inch widths was used. The paper was laid over slightly ridged rows and held with soil over the depressed edges. Suitable provision for transplants or for plant emergence was made by splitting or cutting out disks at the desired intervals—a somewhat laborious process at present but one which can readily be handled at the paper mills if trials appear to warrant it. It is quite possible, moreover, that the machine laying of such prepared paper may be synchronized with the planting.

In the third method, as applied to the growing of drilled crops in field culture, accurately spaced machine seeding has been immediately followed by the laying of strips of type-A paper held with staples, stapled laths, or edgings. Protection against wind damage was hard to secure with this method and type-A papers, and it constituted the most difficult problem in the use of paper mulch with drilled crops. A further problem was that of hand weeding within the row without destroying the paper. This method is shown in Figure 3.

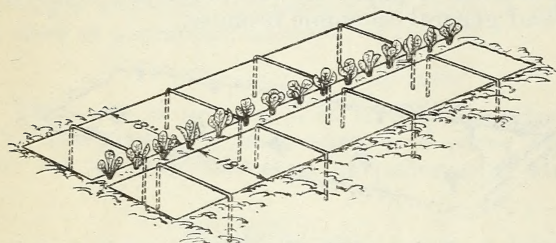


FIGURE 3.—Method of applying strips of paper mulch in block formation, as used with drilled crops in field culture and in home gardens

The above method was also used in the culture of celery, following accurately spaced field planting, and for various flowering plants grown for bulb or cut-flower production.

In the third method, as applied to the growing of

young evergreens, boxwood, and various types of perennial nursery stock, the laying of strips of type-B paper followed the lining out of the plants at suitably spaced intervals. The paper was held with wire staples, stapled laths, or edgings.

A modification of the third method, as applied to the growing of nursery stock, consisted in the use of a strip of paper with notches 2 inches deep cut along one side at the desired intervals. Following the laying of one strip of this paper the plants were set within these notches, and the soil was leveled. The second strip of paper was then overlapped with the straight edge touching the plant stalks and held with stapled laths. Three holes were made in each lath, one near each end and one in the center, and through these holes were inserted straight wire pegs of No. 10 wire, 10 inches long and provided with a double bend at the top to hold the lath. This method proved very effective protection against wind damage except under conditions of pronounced soil heaving with frost, and had the advantage of a practically complete weed suppression.

In home gardens all three of the above methods were used with both the A and B types of paper. The type-B paper was clearly indicated as much more desirable for all home-garden purposes. For ornamental home plantings the paper was covered with pine straw to efface the somewhat unsightly appearance of the black paper.

COSTS

Although most of the mulching paper used in the Hawaiian Islands is manufactured in the United States, the delivered cost in quantity for consumption there is nevertheless appreciably below the present cost of comparable paper in this country. During the past season, however, a number of companies have devoted much effort to the quantity production of mulching papers, and it is probable that with increasing numbers of types of paper and enlarged use, the present costs of papers suitable for various mulching purposes may be gradually reduced. The present cost of the paper-mulching system depends upon the type of paper used and the method of use. With an inexpensive type-A paper costing \$1 per 500 square feet the cost of the paper required for 3 by 3 foot squares spaced at 12-foot intervals would be about \$5.50 to the acre of 302 squares. This minimum expense involves the use of an inexpensive paper, but it will readily be seen that the use of squares of more durable and expensive paper in the establishment of orchards does not appear prohibitive. The cost of the type-B papers varies from two to three or more times the cost of the type-A papers. As used in the production of many annual crops in field culture with the system of extended cropped and mulched rows with uncovered interspaces, the type-A papers, in quantity, have an approximate minimum cost of about \$30 per acre. As used in the practically complete covering of the soil the type-A papers have an approximate minimum cost, in quantity, of about \$60 per acre, while the more durable type-B papers, similarly used, will cost \$120 to \$200 per acre, the cost being distributable against use for two or more crops or seasons.

The cost of applying the paper depends upon the method of use, but ordinarily it appears to be only a small percentage of the cost of the paper.

On the basis of present costs, the use of paper mulch is not profitable in the ordinary production of such crops as field corn, dry beans, cotton, sugar-cane, and other low-value crops. The paper is effective with these crops, however, and it is entirely possible that, should the manufacture of mulching paper from waste by-products (e. g., pressed cane, cornstalks, etc.) prove feasible, its application to low-value crops might become a matter of practical interest.

GENERAL PRECAUTIONS

In making small-scale trials with paper mulch the system was considered as experimental, and provision was made for suitable comparison areas without paper. The papered areas were as nearly as possible of the same fertility as the comparison areas which were not papered. The preparation of the soil and the planting were done at the same time on both areas, and any fertilizer subsequently applied was applied equally to the mulched and unmulched areas. Under irrigation conditions special precautions were taken to prevent excessive moisture under the paper, and on moist soils the paper was extended over ridged and slightly elevated beds to facilitate drainage.

In conducting the initial trials the main objective was the determination of the extent of crop-plant stimulation attributable to the use

of a black, impervious paper. When this was ascertained it constituted a basis for any study of particular papers and methods of applying them which seemed desirable.

As stated on page 18 of Technical Bulletin No. 75,² certain methods of using mulch paper are patented. The present licensees are the Paraffine Companies (Inc.), of San Francisco, Calif.; Bird & Son (Inc.), East Walpole, Mass., and Chicago, Ill.; and The International Paper Co., 100 East Forty-second Street, New York, N. Y. So far as these investigations show, any impervious dark paper free from soluble toxic materials may be as efficacious in stimulating plant growth as that manufactured especially for use as a mulch.

The successful application of paper mulch in other regions has been brought about only through modest initial trials annually extended as more information was obtained. There appears to be no reason why the present inquiry regarding the attractive possibilities of this system should not be extended in a similar manner.

² FLINT, L. H. Op. cit.

ADDITIONAL COPIES

OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
U. S. GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.

AT

5 CENTS PER COPY



